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VLASOV ANTENNA DATA FOR ELECTROMAGNETIC CODE VALIDATION

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Final Report

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This report has been approved for publication.

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14. ABSTRACT
Measured antenna data is provided for validating computational electromagnetic (CEM) computer programs. The subject antenna is the Vlasov antenna, which is formed by cutting a hollow circular cylindrical waveguide at an oblique angle. Measurements are shown for return loss as a function of frequency, the antenna gain as a function of angular location at three frequencies, and the antenna gain as a function of frequency at several angular locations.

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1 Introduction

The purpose of this report is to provide measured antenna data for use in validating computation electromagnetic (CEM) computer programs. The subject antenna is the Vlasov antenna[1]–[3], which is formed by cutting a hollow circular waveguide at an oblique angle. The measurements in this report are from an antenna that is cut at an angle of 26.1843°. The end of the antenna is also removed according to the dimensions shown in Section 2. This report shows measurements of the antenna return loss as a function of frequency and the gain as a function of frequency at several angular locations. The gain as a function of angular location is also shown at three distinct frequencies.

2 Geometry

The Vlasov antenna radiates an incident TM_{01} circular waveguide mode. The feed structure employed to launch at TM_{01} circular waveguide mode is shown in Fig. 1. As mentioned in Section 1, the Vlasov antenna of this report is formed by cutting a hollow circular waveguide at an angle of 26.1843°, as shown in Fig. 2. Fig. 2 also shows how the end of the angular cut is removed. The angles used in the gain plots of Section 3 are measured in degrees above the antenna axis as shown in Fig. 2. Thus, the coordinate system of Fig. 2, an angle of 0° corresponds to a point in the z-axis while an angle of 90° corresponds to a point on the y-axis.

3 Data

Fig. 3 shows the measured return loss (S_{11}) of the antenna and feed structure as a function of frequency from 1.1 GHz to 1.7 GHz. Fig. 4 shows the measured antenna gain as a function of angle from 0° to 90° at 1.15 GHz, 1.20 GHz, and 1.30 GHz. Fig. 4 also shows the results of antenna gain calculations made with the commercial finite element method (FEM) code HFSS[4]. These calculations serve primarily as a data check on the measurements and are not intended as high fidelity code validation data. Figs. 5–8 show the measured antenna gain as a function of frequency from 1.1 GHz to 1.7 GHz at angles of 0°, 4°, 14°, 24° (Fig. 5); 28°, 32°, 34°, 36° (Fig 6); 40°, 44°, 54°, 64° (Fig 7); and 74°, 84° (Fig. 8).

4 Conclusion

The data in this report is intended to aid in the validation of antenna CEM computer programs. It is hoped that the authors of such programs find the data useful.

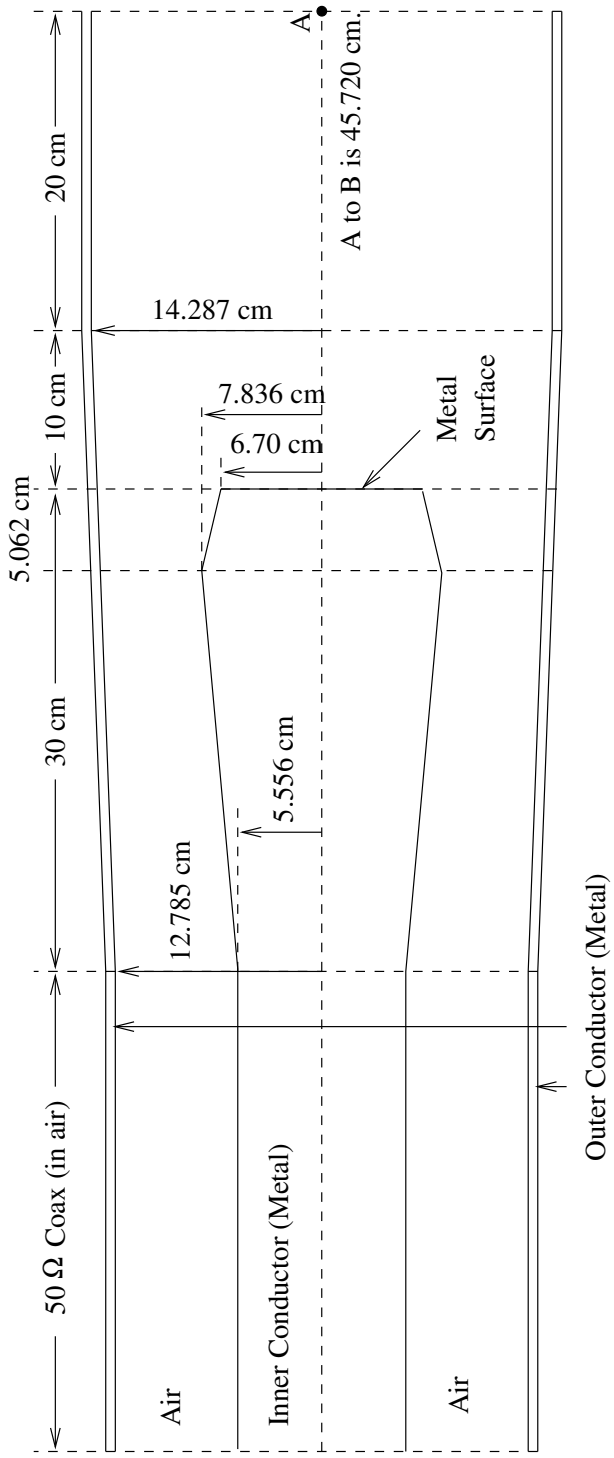

Figure 1: Antenna feed structure.

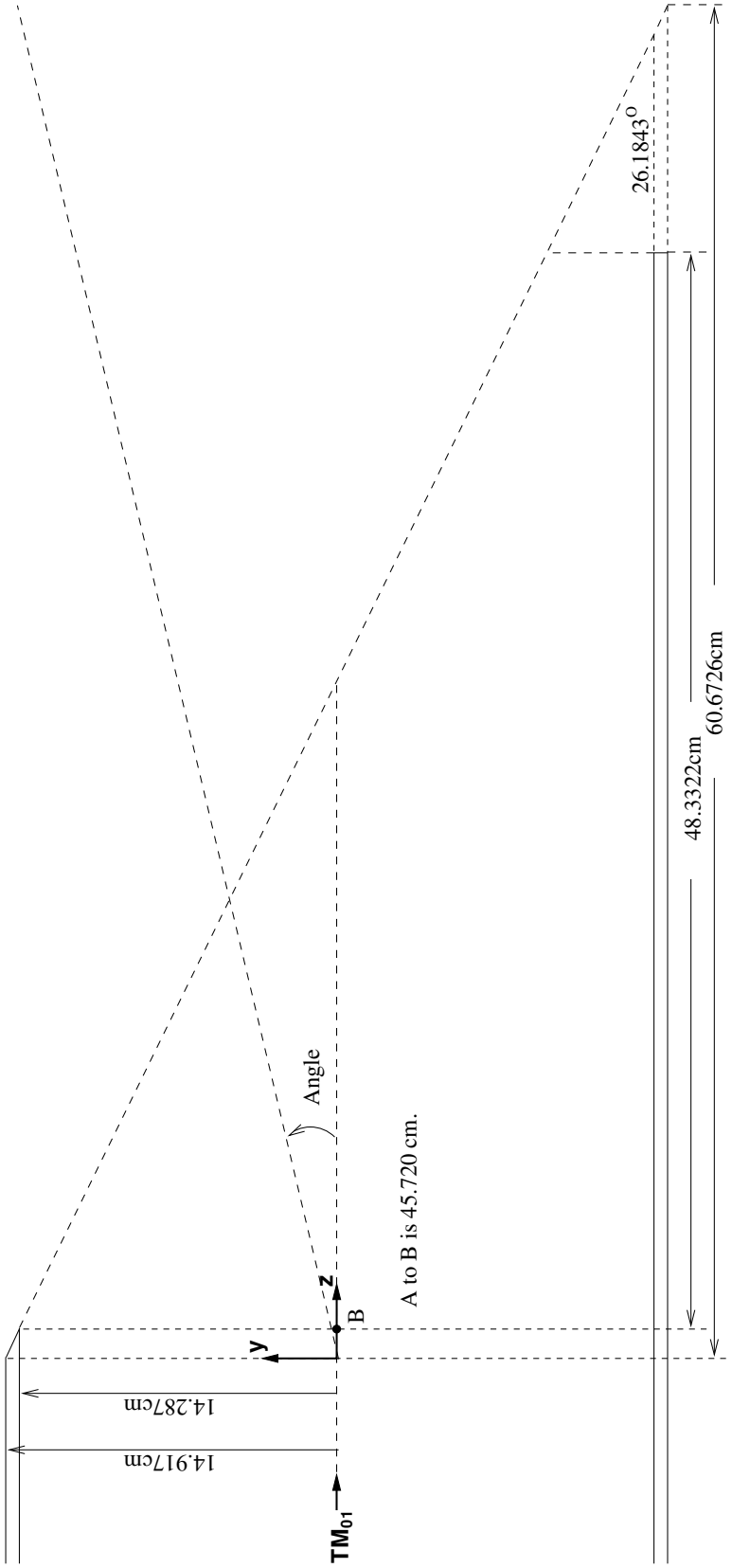

Figure 2: Vlasov antenna geometry.

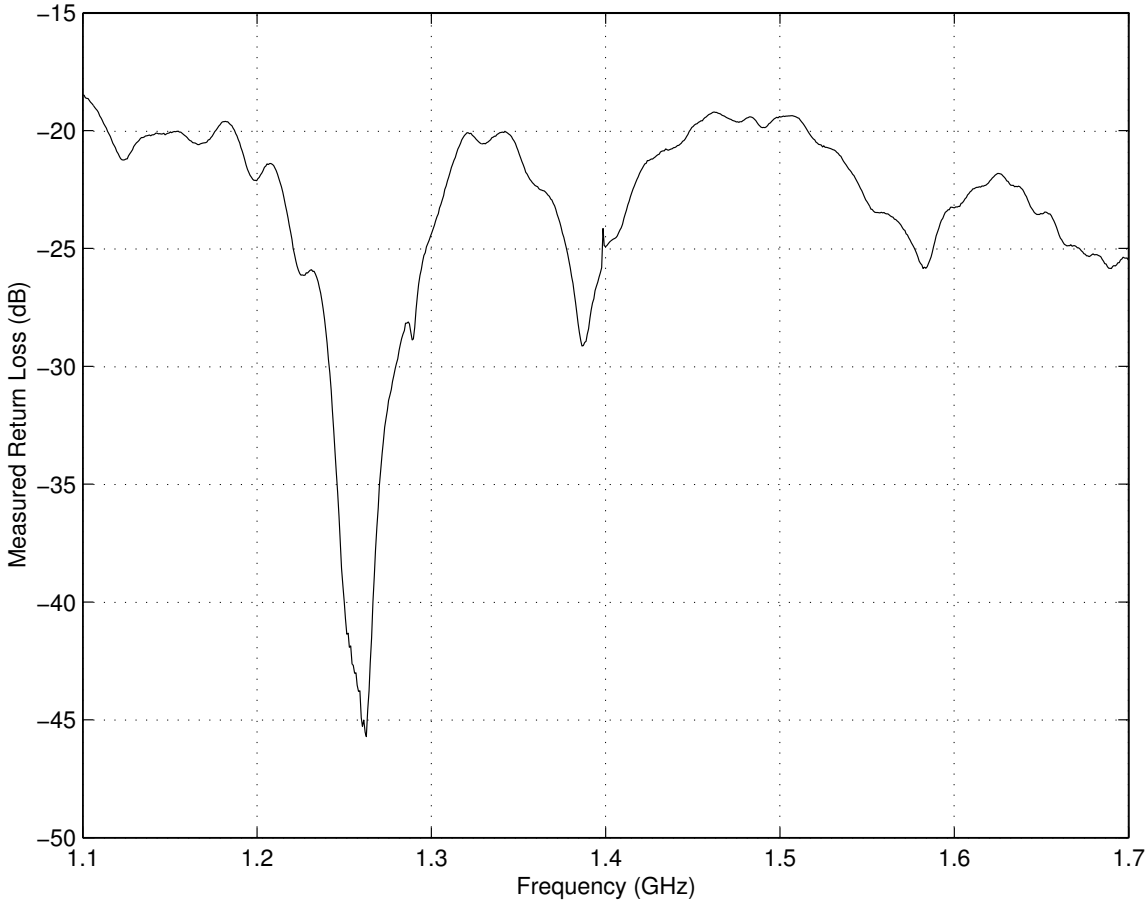

Figure 3: Measured antenna/feed return loss S_{11}.

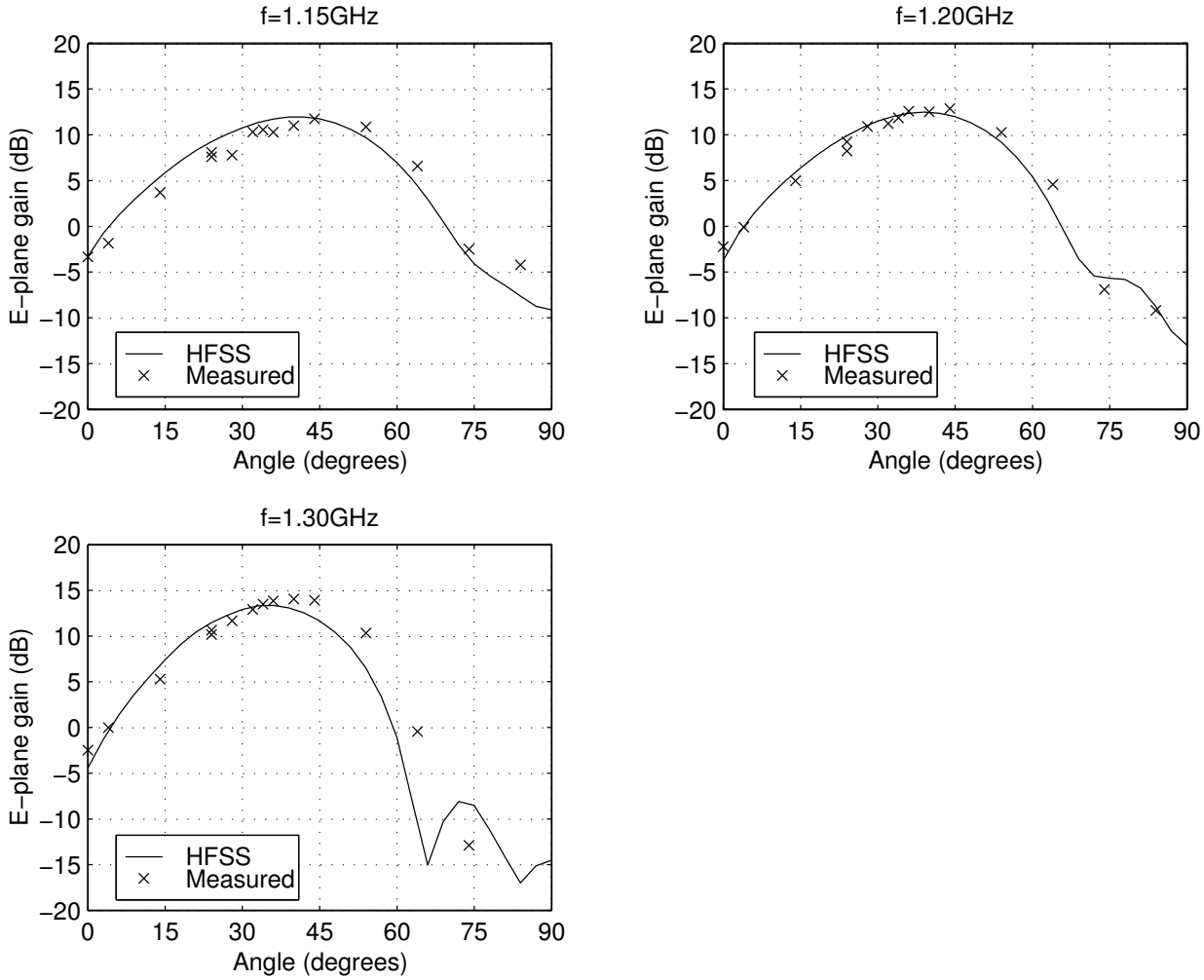

Figure 4: Measured and HFSS computed antenna gain as a function of angle at 1.15 GHz, 1.20 GHz, and 1.30 GHz.

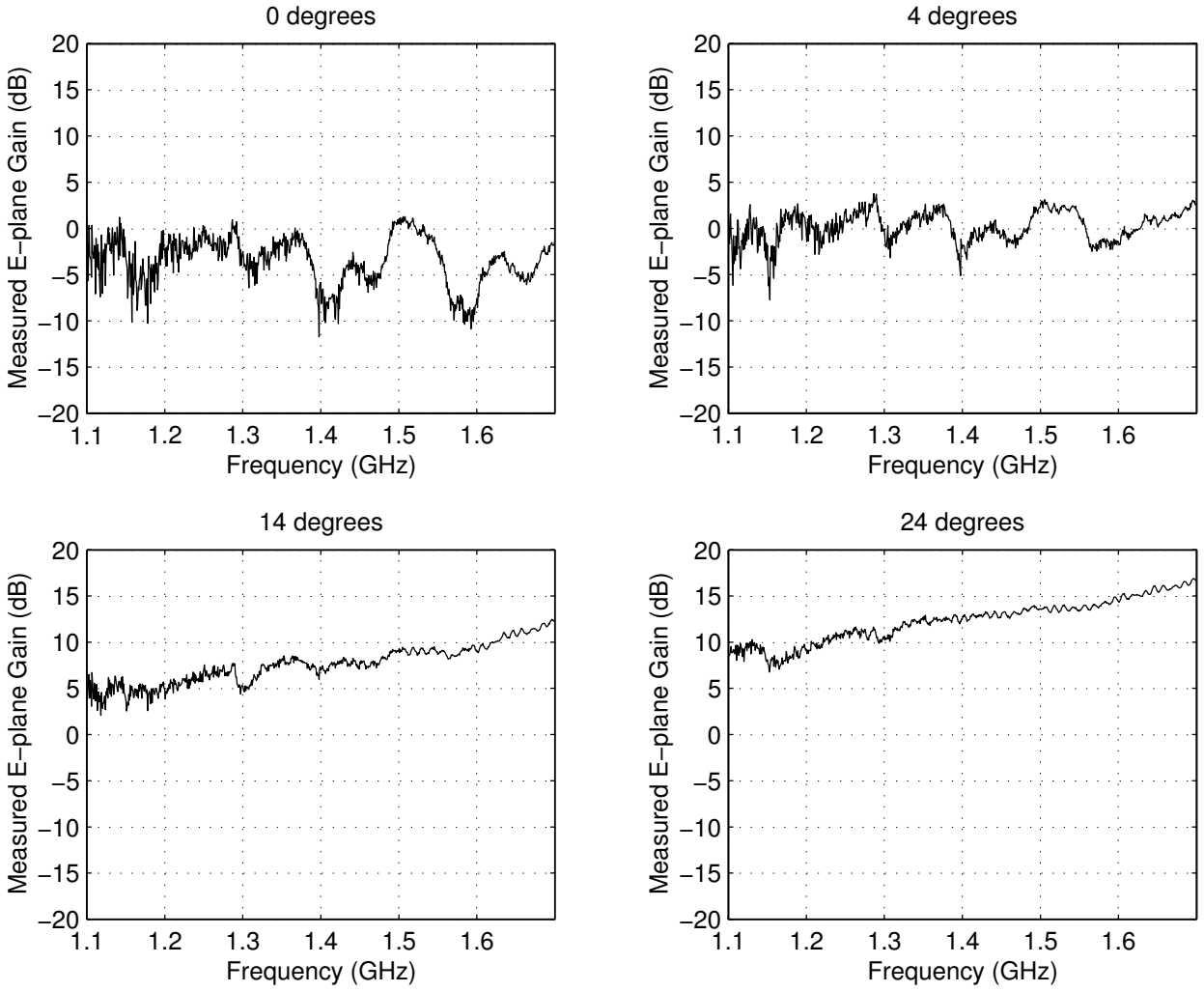

Figure 5: Measured antenna gain as a function of frequency at $0°$, $4°$, $14°$, and $24°$.

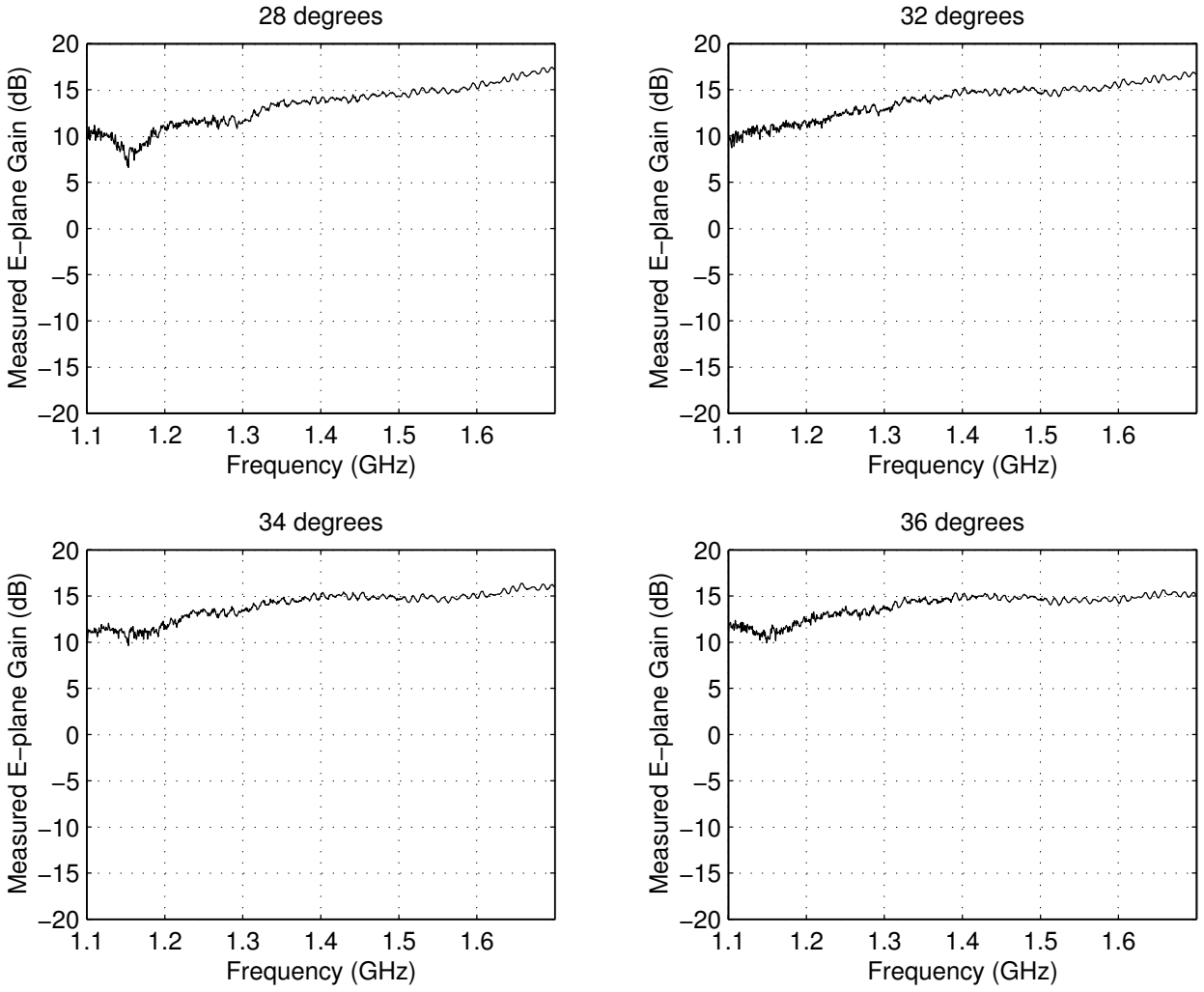

Figure 6: Measured antenna gain as a function of frequency at $28°$, $32°$, $34°$, and $36°$.

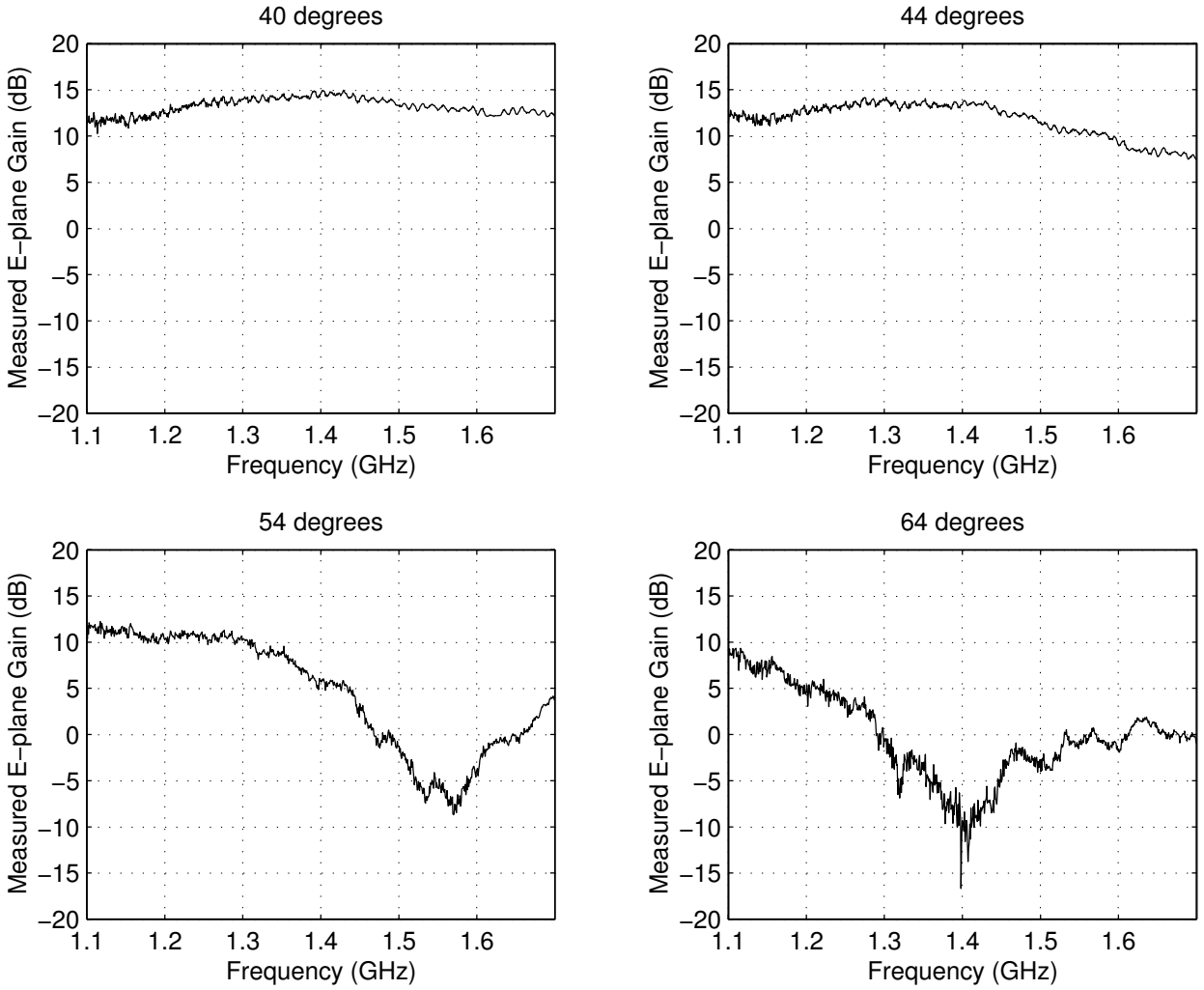

Figure 7: Measured antenna gain as a function of frequency at $40°$, $44°$, $54°$, and $64°$.

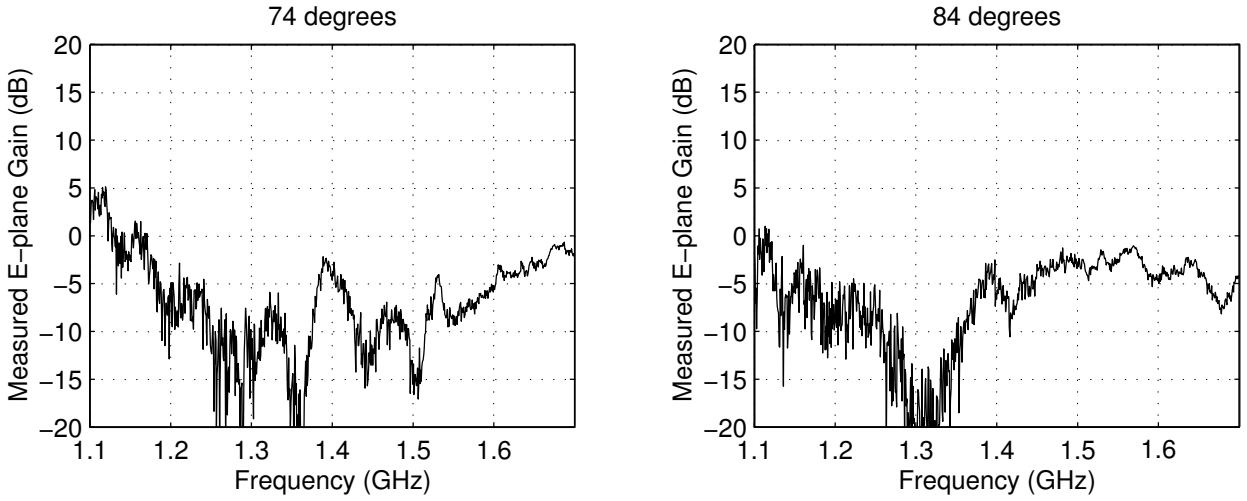

Figure 8: Measured antenna gain as a function of frequency at 74° and 84°.

References

[1] S. N. Vlasov and I. M. Orlova, "Quasioptical transformer which transforms waveguide having a circular cross section into a highly directional wave beam," *Radiofizika*, vol. 17, pp. 148–154, January 1974.

[2] B. G. Ruth, R. K. Dalstrom, C. D. Schlesiger, and L. F. Libelo, "Design and low-power testing of a microwave vlasov mode converter," in *IEEE MTT-S International Microwave Symposium*, vol. 3, pp. 1277–1280, 1989.

[3] J. H. Beggs, *Finite-difference time-domain implementation of surface impedance boundary Conditions in one, two, and three dimensions*. PhD thesis, The Pennsylvania State University, 1993.

[4] http://www.ansoft.com.

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